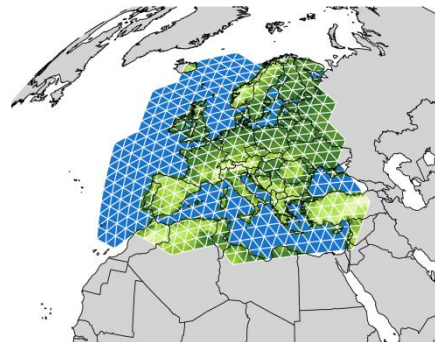


ICON modelling framework at DWD

ICON





Max-Planck-Institut
für Meteorologie



Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Diversity and Partnership

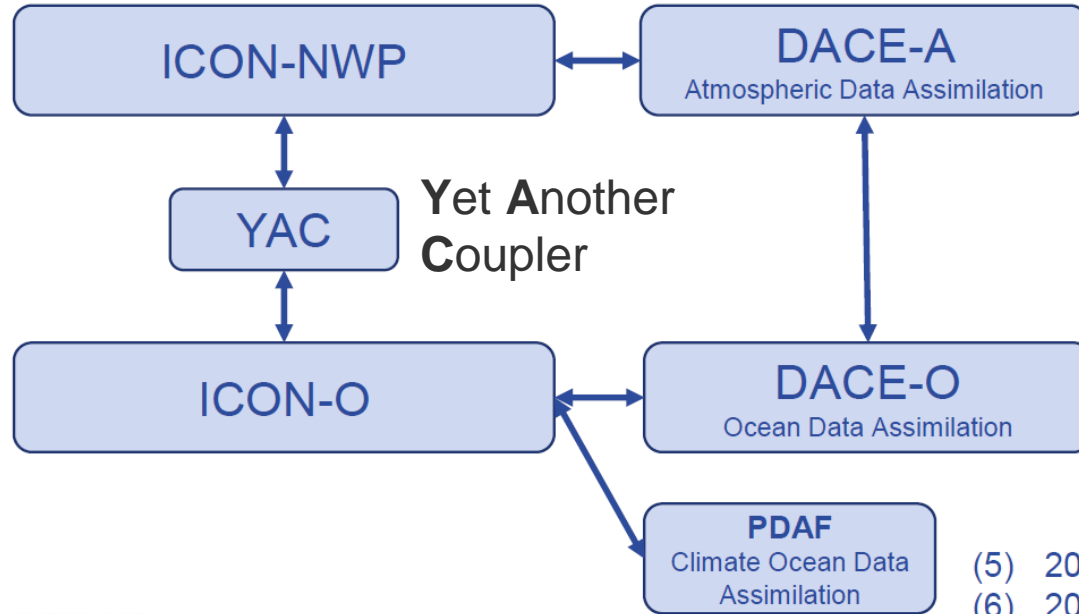
MPI: Advance Climate Science, Atmosphere, Ocean, Land, understanding of global processes driving the planet

DWD: Forecasting for Weather (NWP/ESM) and Climate (Seasonal, Decadal, Projection), Climate Monitoring (Reanalysis), ART and GHG Monitoring and Forecasting

DKRZ: Infrastructure for Climate Science, Tools and Techniques, HPC Leadership

KIT: Modelling and Forecasting of Aerosols and Greenhouse Gases, ART and Cloud Process Interaction

ICON seamless **ESM** 0-7 days & seasonal to decadal



- (1) 2023 **Coupling A+O YAC** on NEC *Experimental* Data Assimilation, **ICON-O-LAM** technical
- (2) 2024 Coupling A+O in BACY Verification available **Data Assimilation** in DACE technical **ICON-O-ZOOM** technical
- (3) 2025 **Near-Realtime Tests** with BACY, Data Bases, NUMEX Prep, **ICON-O-LAM Data Ass.** technical
- (4) 2026 Implementation in NUMEX **Deterministic Cycle with Data Assimilation** preoperational
- (5) 2027 **LETKF** implementation and testing
- (6) 2028 hybrid **EnVAR + LETKF** implementation and testing
- (7) 2029 **NUMEX** for hybrid system, Testing
- (8) 2030 **Ensemble-Variational ESM** ready for operational forecasting

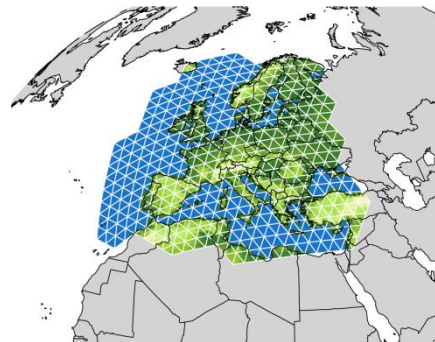


GeoInfoDienst Bw
and DWD

Starting Q3/2022

Major upgrades of the ICON-NWP system at DWD planned for 2022

ICON



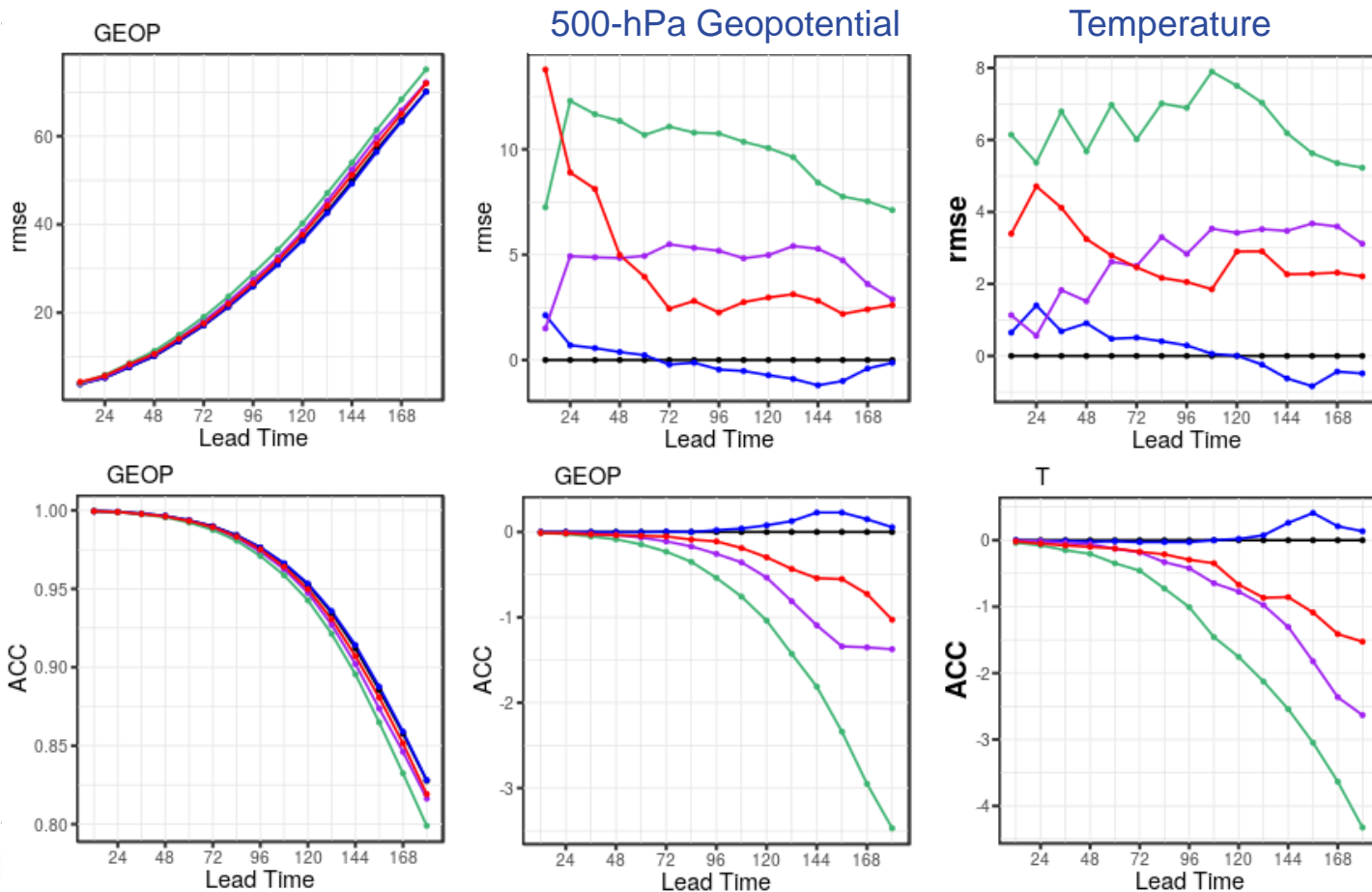
by Günther Zängl

Overview

- **Resolution upgrade in global ICON (including EU-nest)**
- Usage of new global high-resolution orography data
- Assimilation of 2m-temperature and enhanced coupling between model and data assimilation building upon it

Planned to become operational in Q4/2022

Horizontal resolution Verification against IFS analyses



EPS mean

differences to
operational
configuration

13km

experiments

40

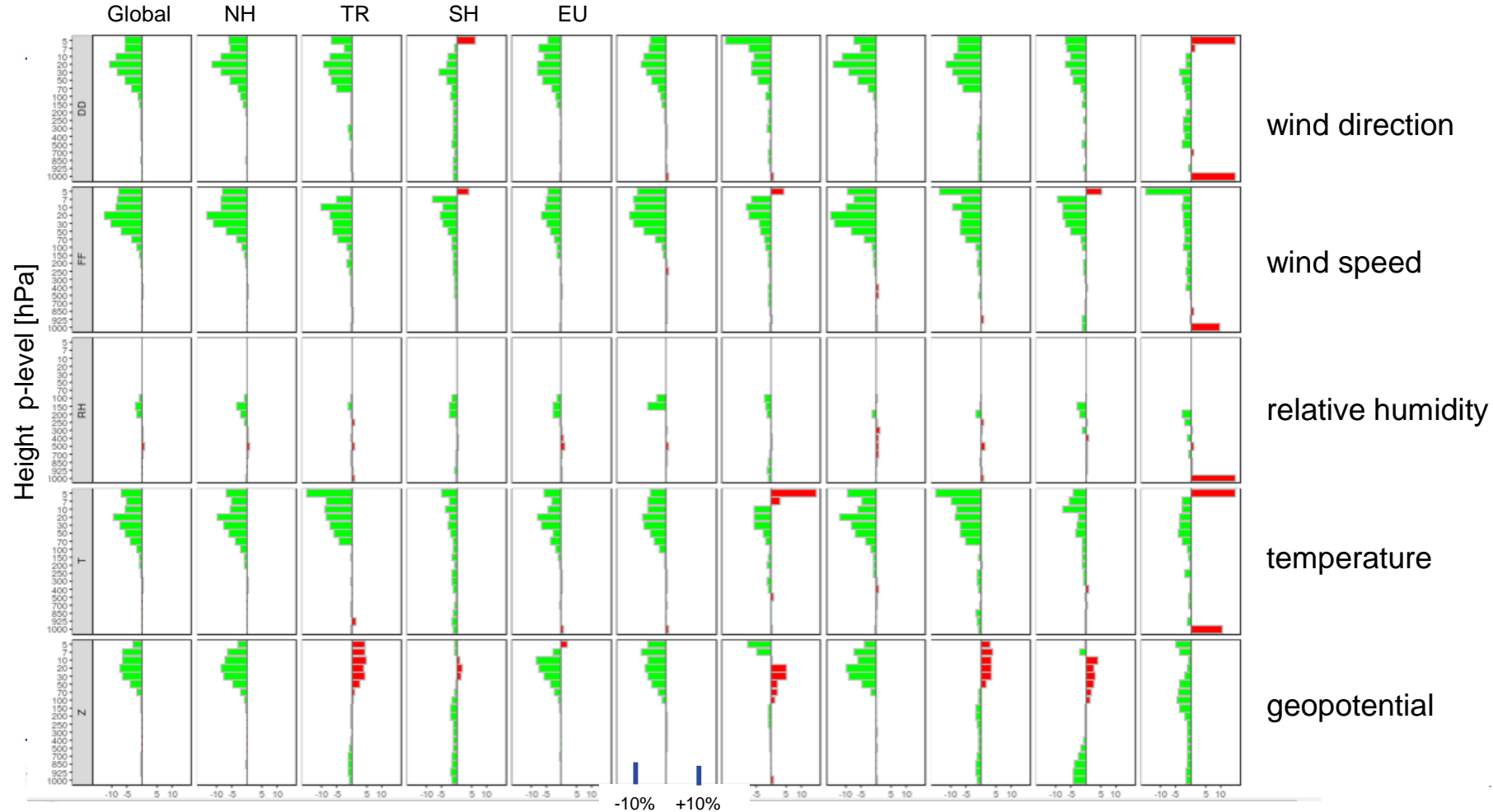
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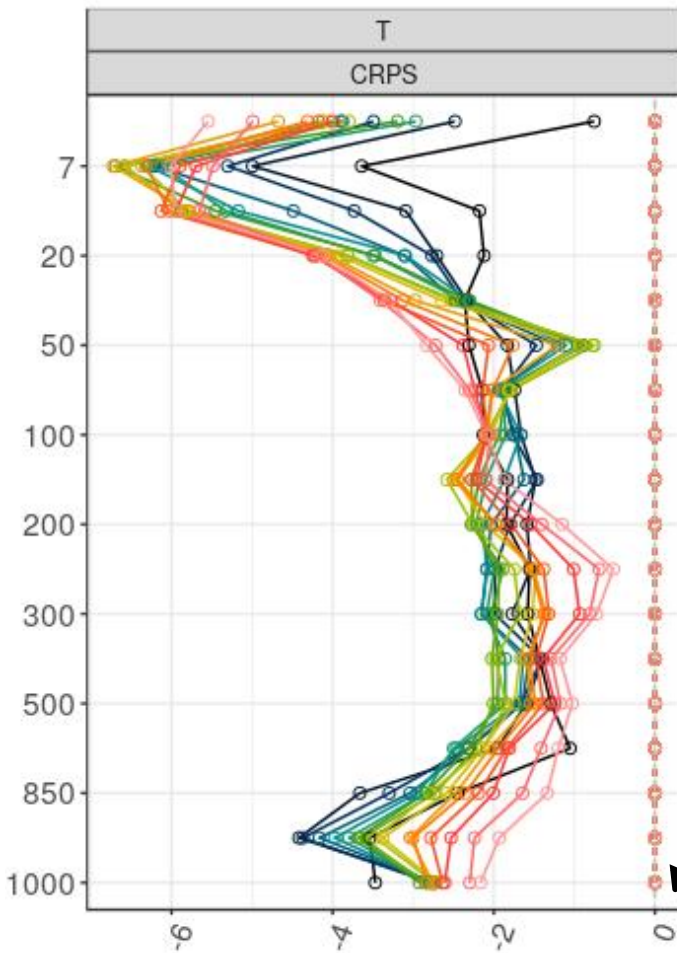
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6.5

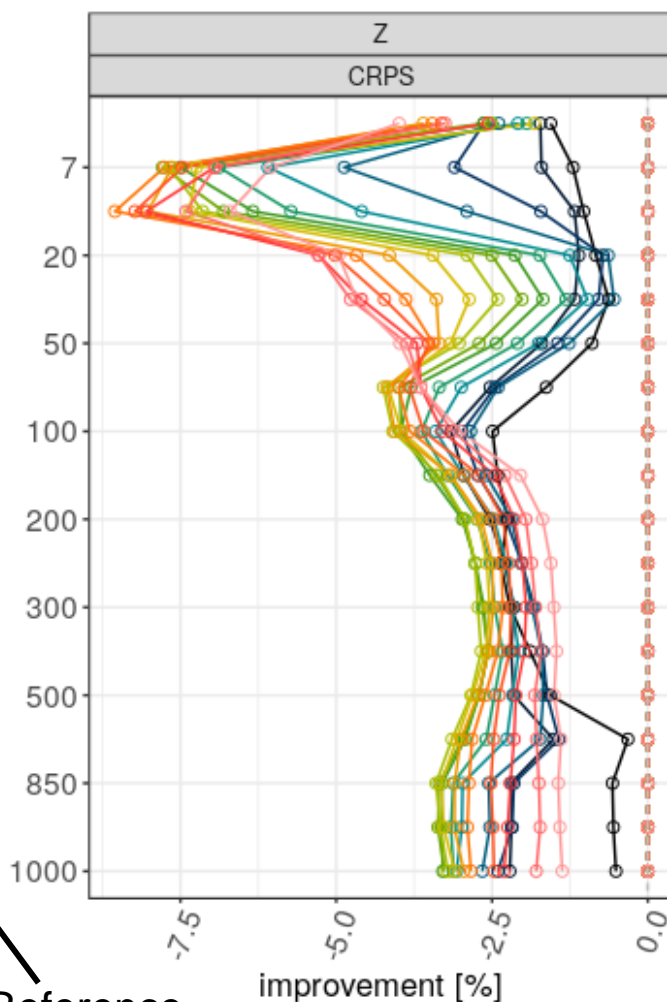
120 vs. 90 levels: radiosonde verification: -> green: 120 levels better

RMSE reduction





Reference



lead-time [h]

000
012
024
036
048
060
072
084
096
108
120
132
144
156
168
180

Sig. diff. (95%)

○ n.a.
○ no
● yes

Combined
resolution
upgrade

CRPS
reduction [%]

Global EPS

radiosonde
verification

Main findings

- Increasing the horizontal resolution improves the forecast quality until reaching the convective gray zone
- Increasing the vertical resolution is beneficial where the resolution is currently rather coarse, i.e. above the middle troposphere; PBL turns out to be tricky...

Decisions

- Increase **EPS resolution** from 40/20 km to **26/13 km** while keeping the deterministic configuration at 13/6.5 km; increase number of **vertical levels** from 90 to **120** (60 to **74 in EU-nest**), placing the majority of the additional levels in the stratosphere

Remark:

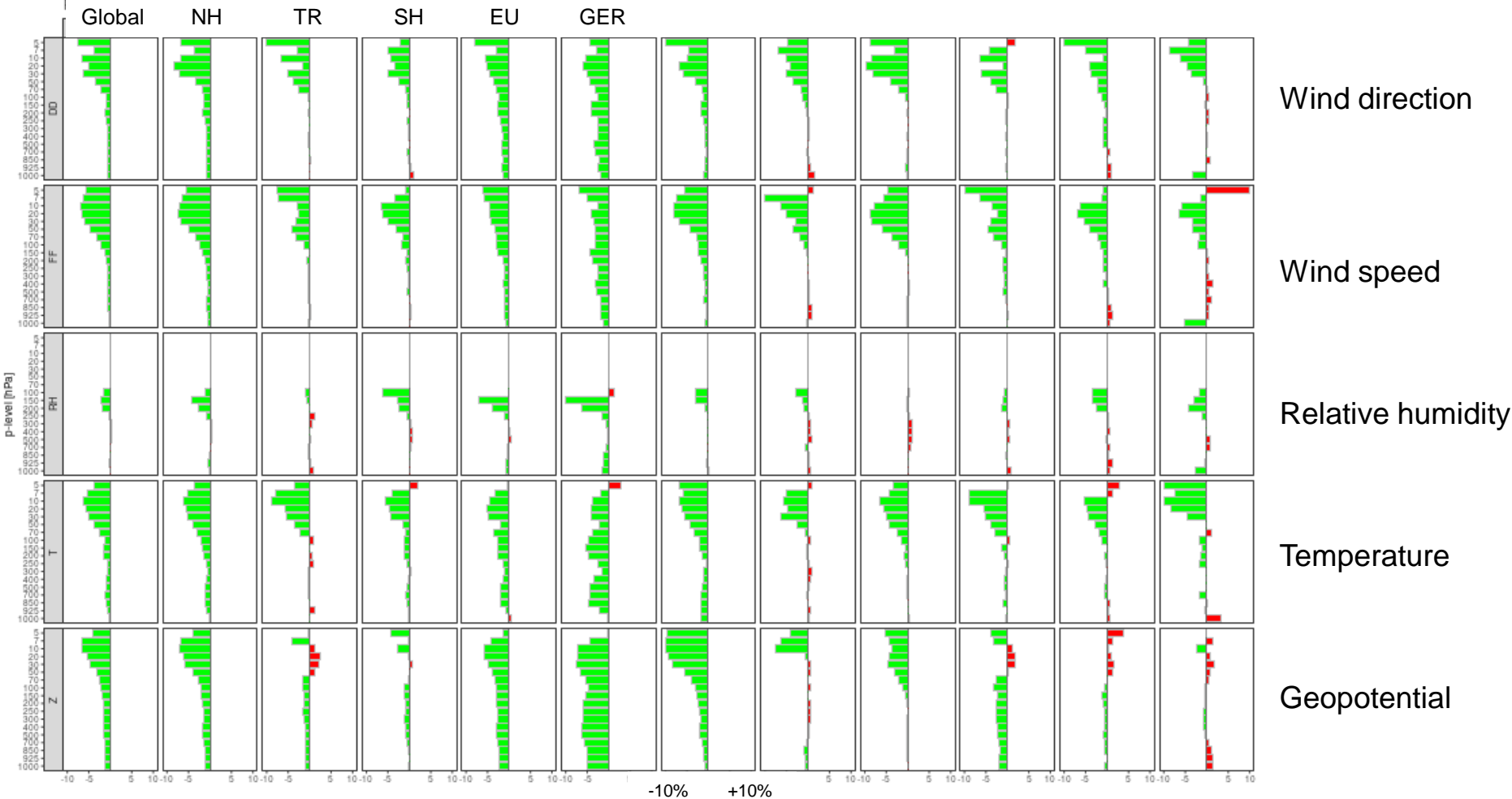
The higher EPS resolution leads to a significant improvement of the deterministic high resolution forecasts as well

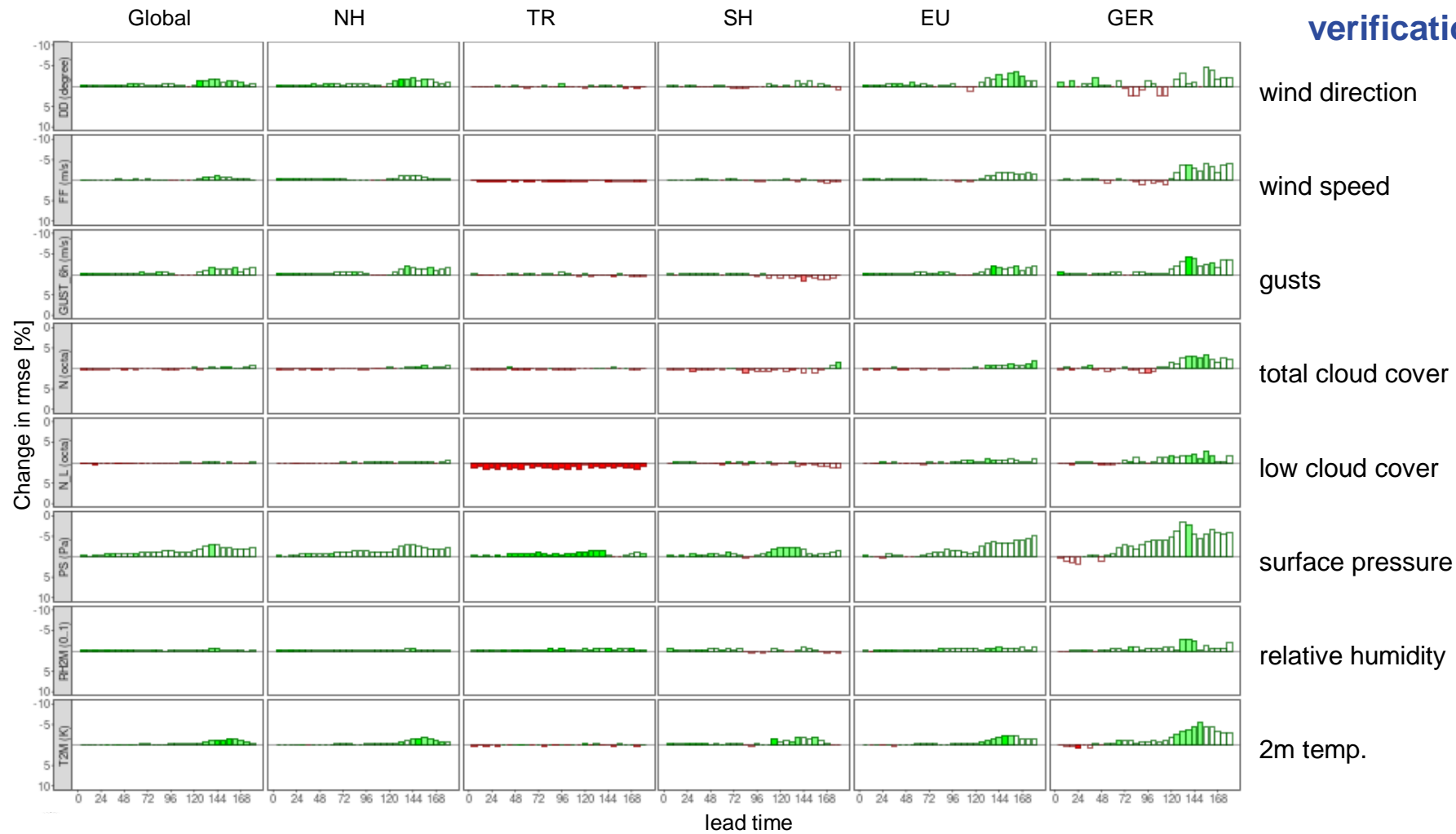
- Variational solver depends on the ensemble resolution
- Improved Ensemble error covariances in 3DEnVar data assimilation

Verification period 2020/10/20 – 2021/01/08

RMSE reduction

radiosonde verification: DET -> green: better



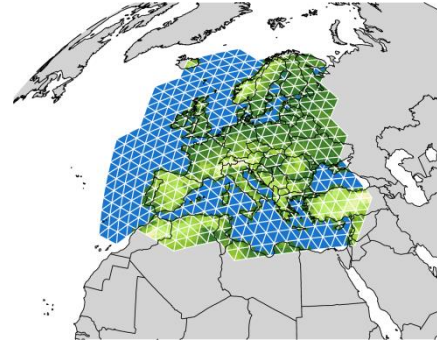


Summary

- The resolution upgrade will bring a moderate improvement of forecast quality in the deterministic system and a major one in the ensemble
- The new orography data allow for a more accurate calculation of SSO parameters, which will have a beneficial impact on forecast quality particularly in NH winter. Lower-tropospheric winds benefit from using seemingly marginal SSO information
- The T2M assimilation and the extended model-DA coupling building upon it leads to a major improvement of T2M and RH2M scores for short-range forecasts, gradually decreasing but remaining significant in the medium range

Cyclone Tracking at DWD

ICON



Freie Universität



Berlin

WTRACK

ZYPACK

Tropical and extratropical Cyclones

- Time stepping (hourly to 6-hourly)
- Any Grid configurations
- Grid resolutions (13km to 160km)
- Applications for Weather and Climate
- Tracking of wind and precipitation fields
- **Contributions to TC-PFP**



TC-Tracking

**Extratropical
cyclones**

Delay due to lack
of resources

-> Q1/2023

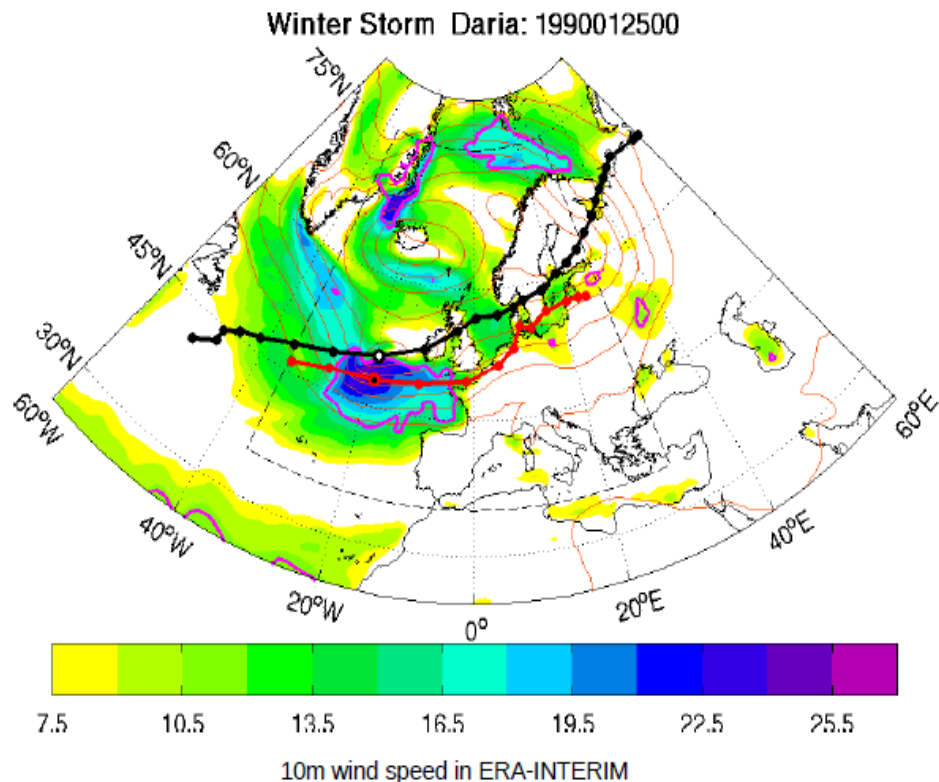
WTRACK

→ Tracking of windfields



New:

→ Tracking of precipitation fields



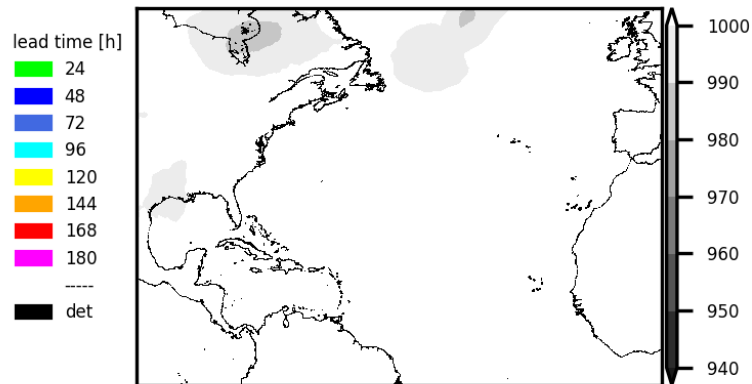
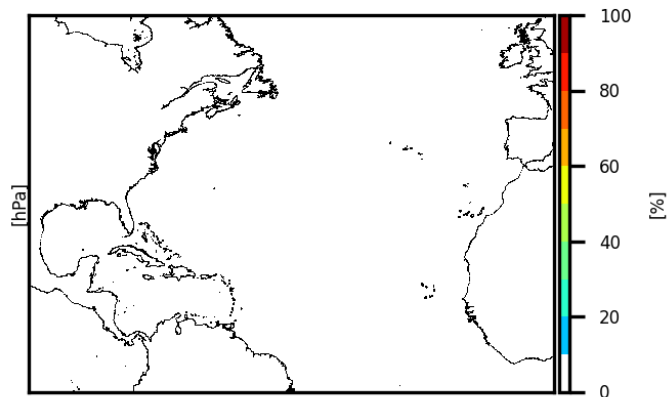
Example:

Simple Tracking algorithm (MSLP minimum) running at DWD

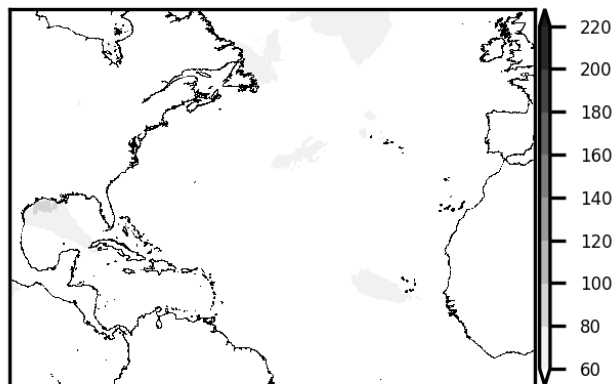
Ensemble Tracks	Strike Probability
90% percentile of mean wind speed	90% percentile of max precipitation

- 2021082600 - 202109312
- Forecasts initialize every 12h
- **Storms**
Ida (Kate) (Julian) Larry
4 Storm Storm 3

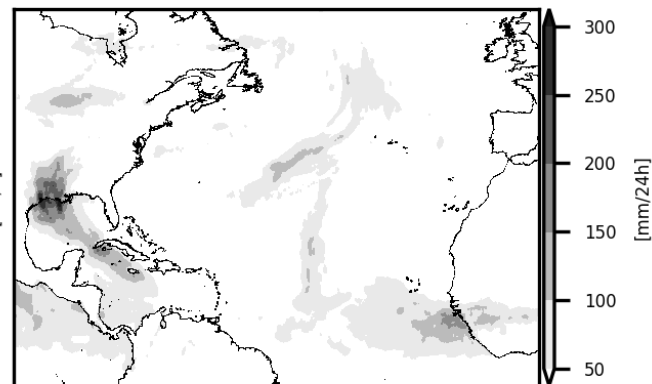
tracks & min of MSLP during forecast

strike prob. ($r \sim 120\text{km}$) / forecast range (0-180h)

90% quantile of max wind speed + det. Track

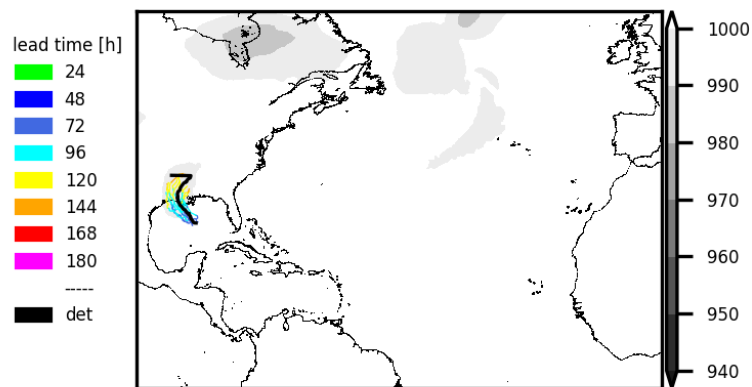
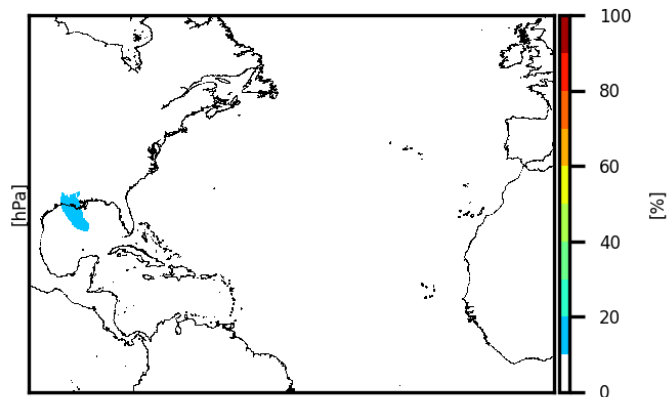


90% quantile of max rain/24h + det. Track

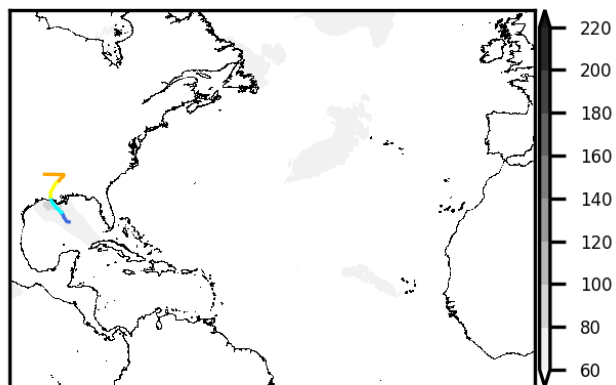


Ida
(Julian)
(Kate)

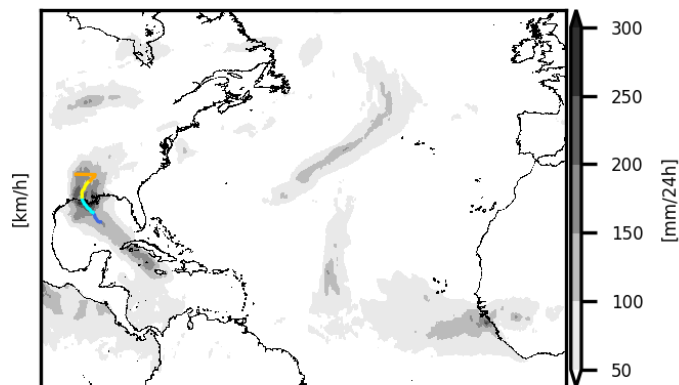
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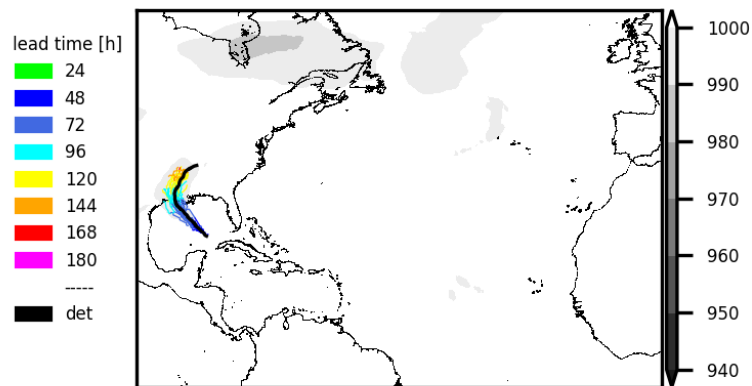
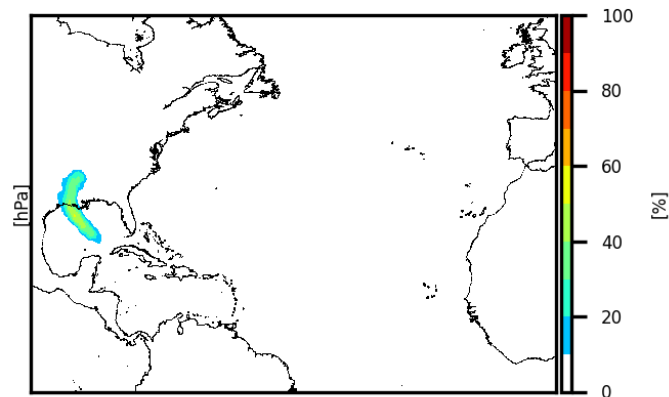


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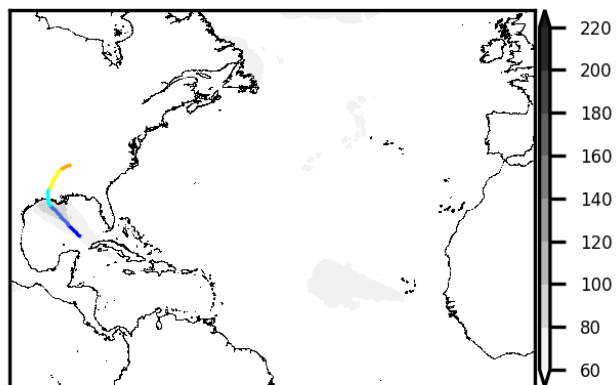


Ida
(Julian)
(Kate)

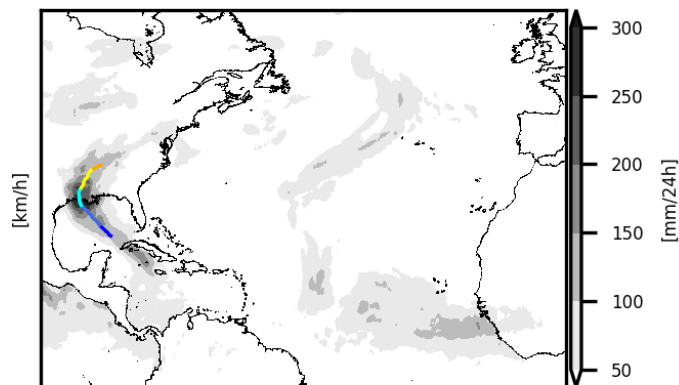
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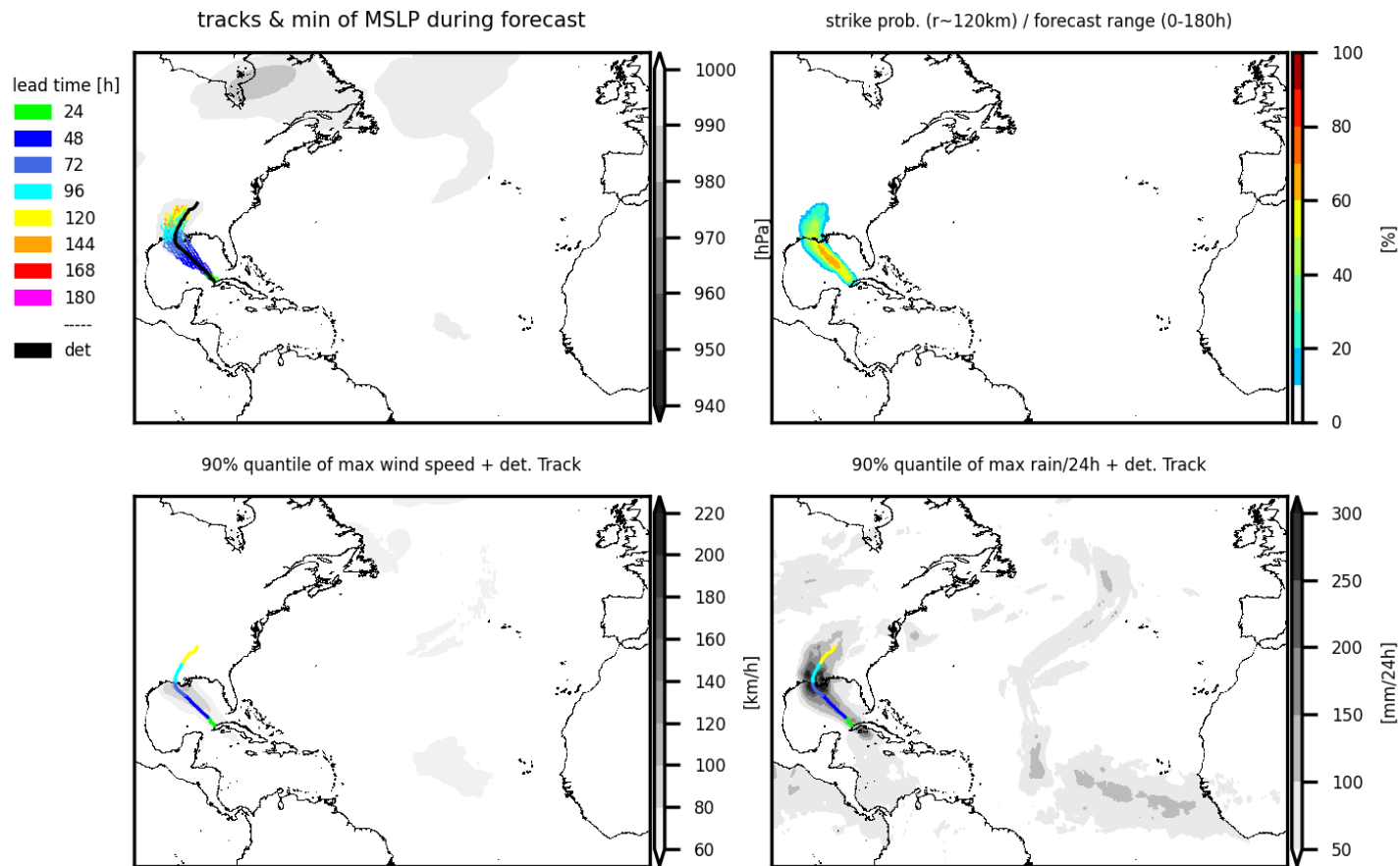
90% quantile of max wind speed + det. Track



90% quantile of max rain/24h + det. Track

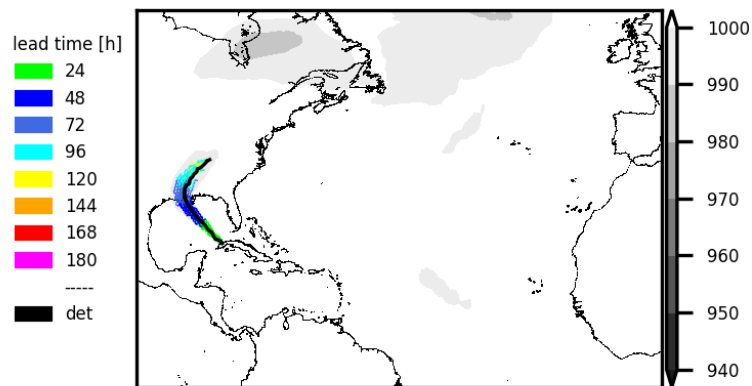
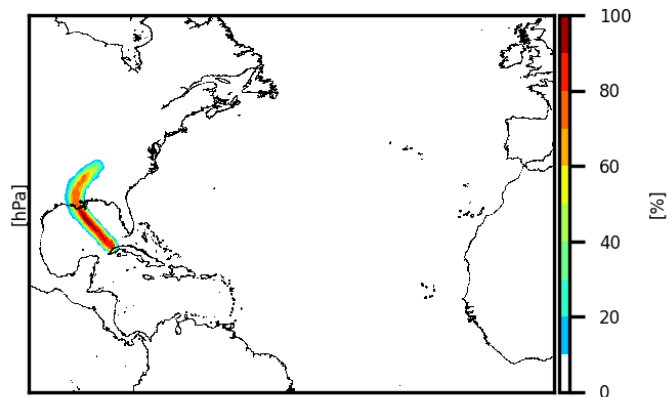


Ida
(Julian)
(Kate)

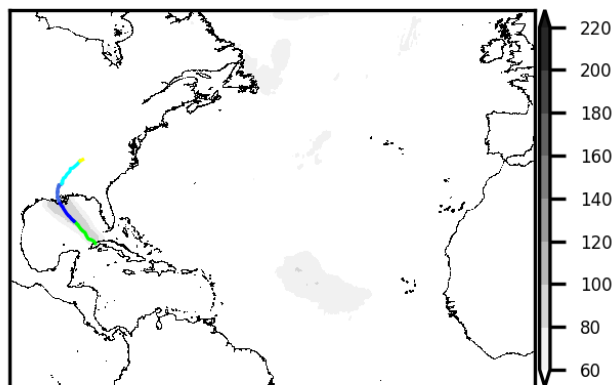


Ida
(Julian)
(Kate)
Larry

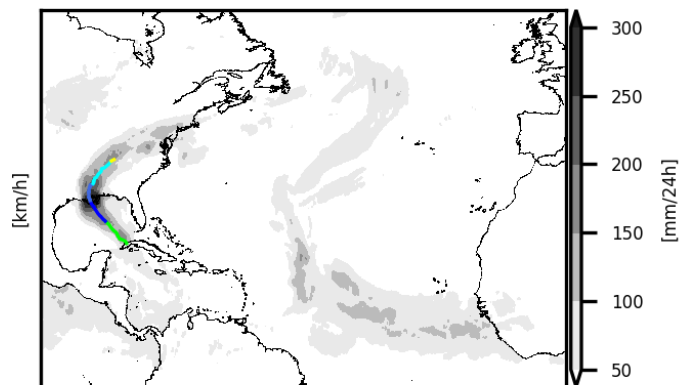
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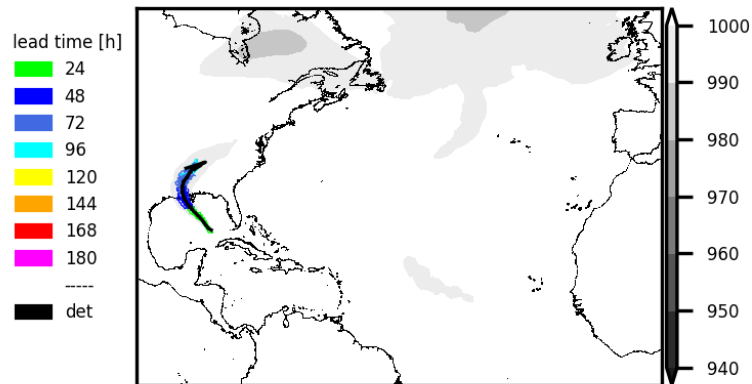
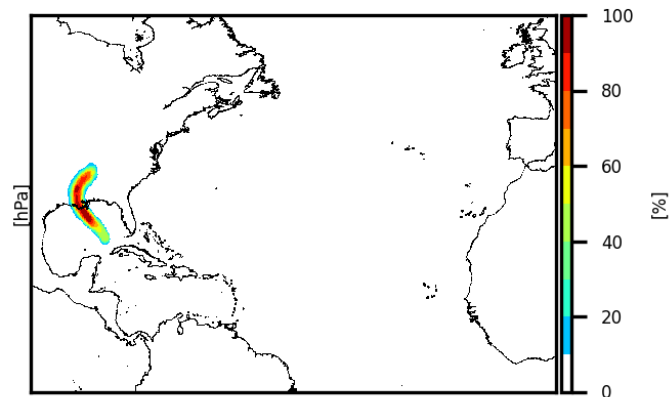


90% quantile of max rain/24h + det. Track

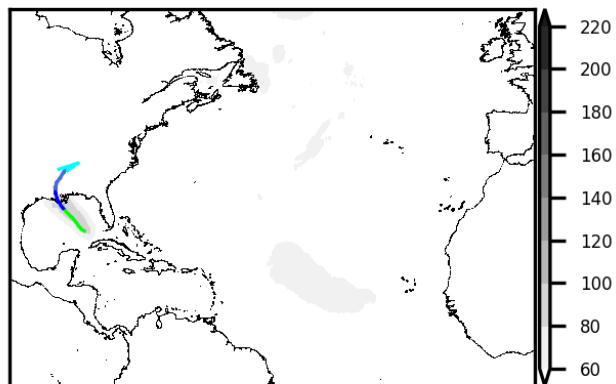


Ida
(Julian)
(Kate)
Larry

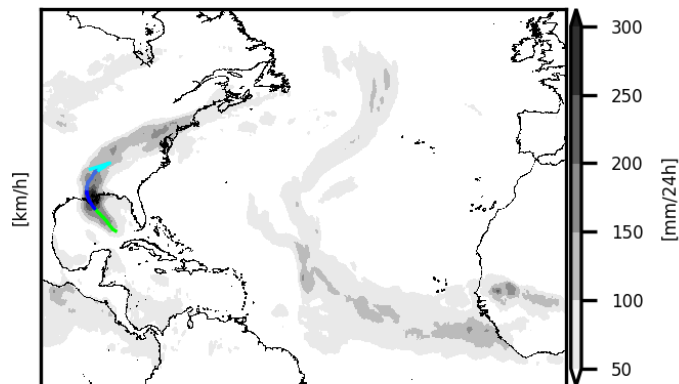
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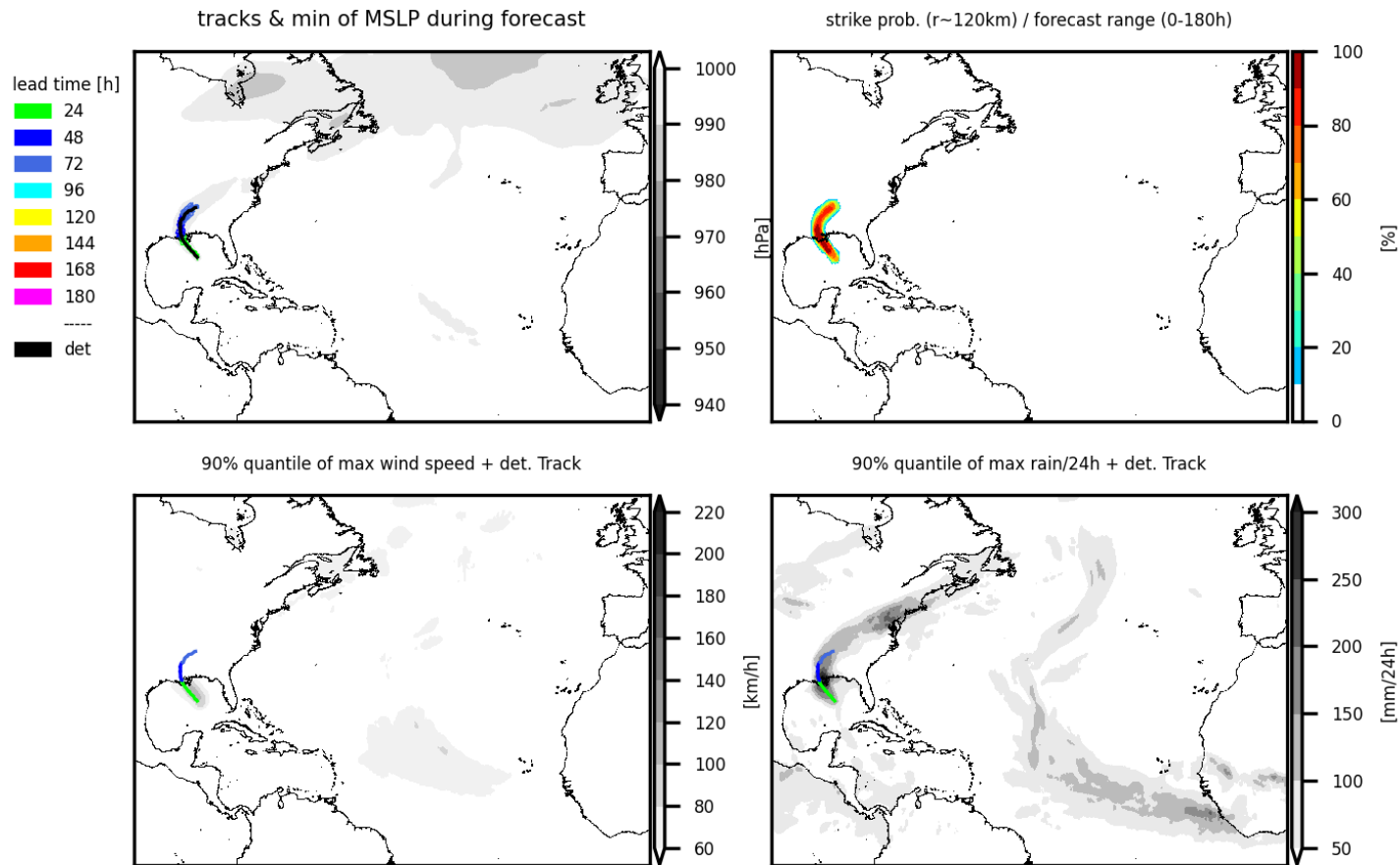
90% quantile of max wind speed + det. Track



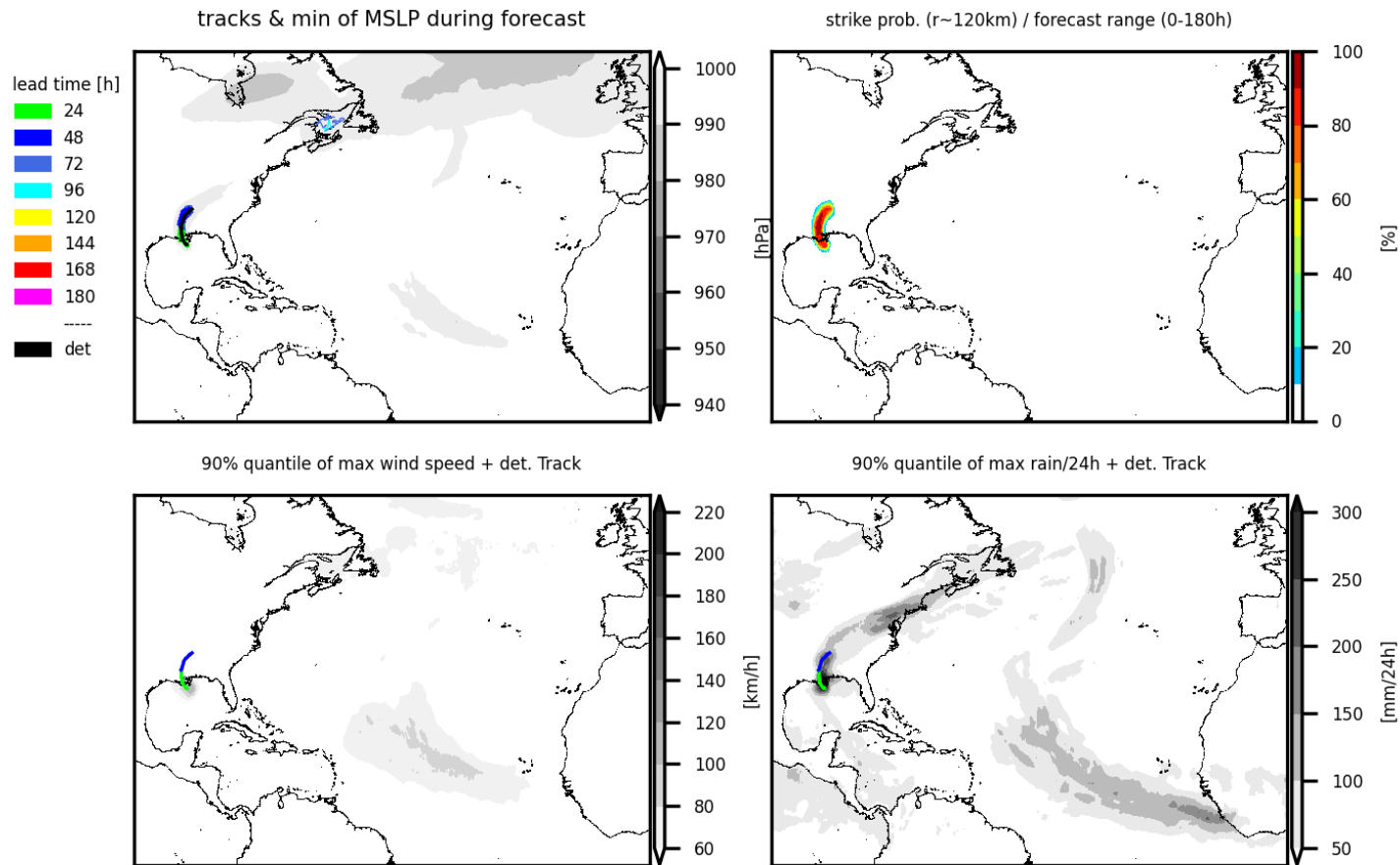
90% quantile of max rain/24h + det. Track



Ida
(Julian)
Larry

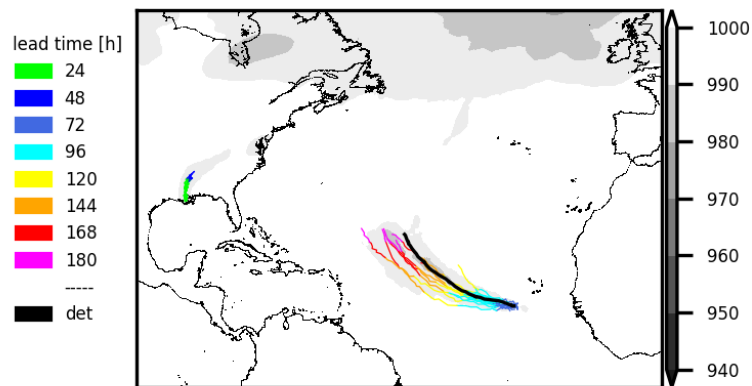
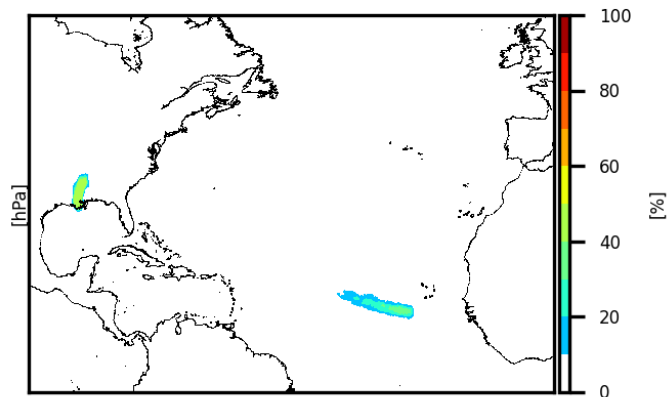


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(Julian)
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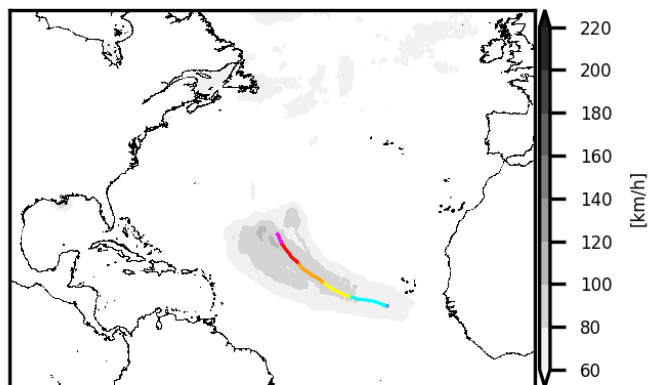


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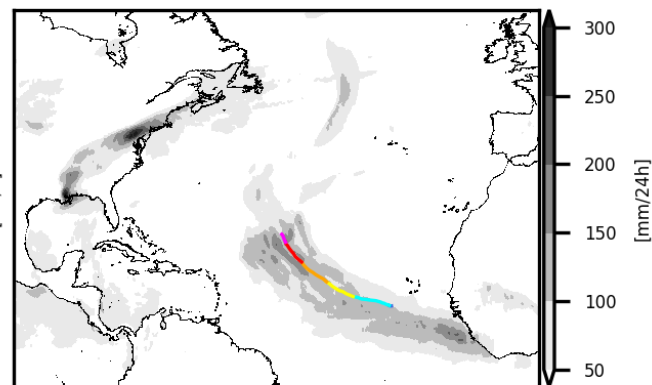
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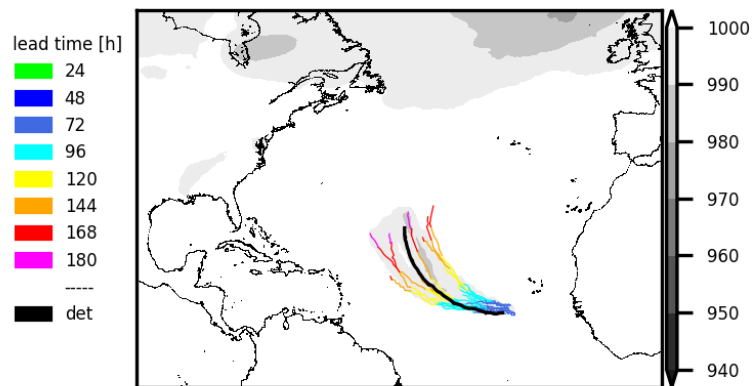
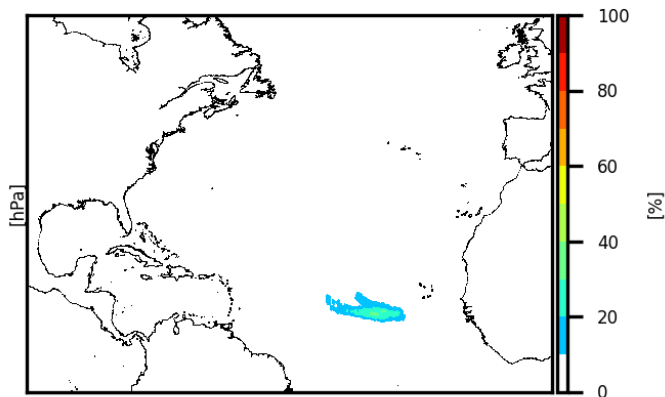


90% quantile of max rain/24h + det. Track

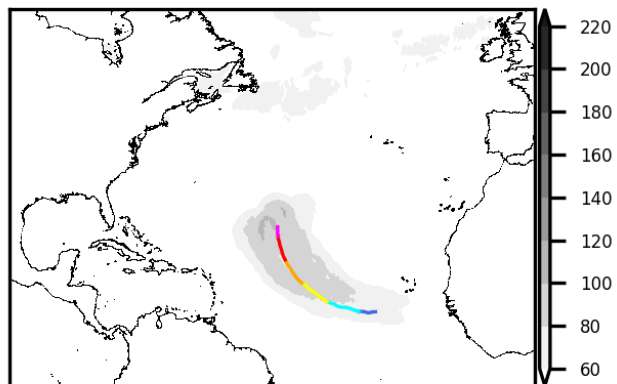


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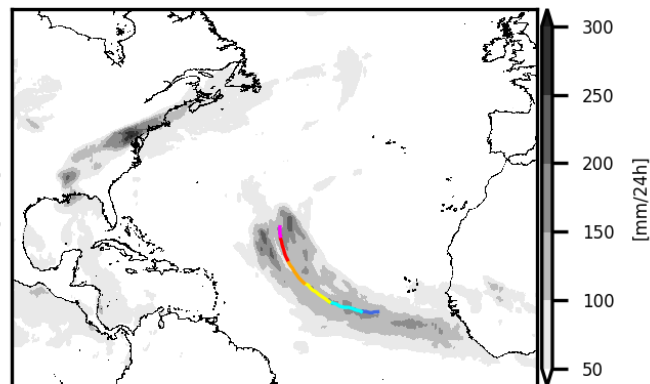
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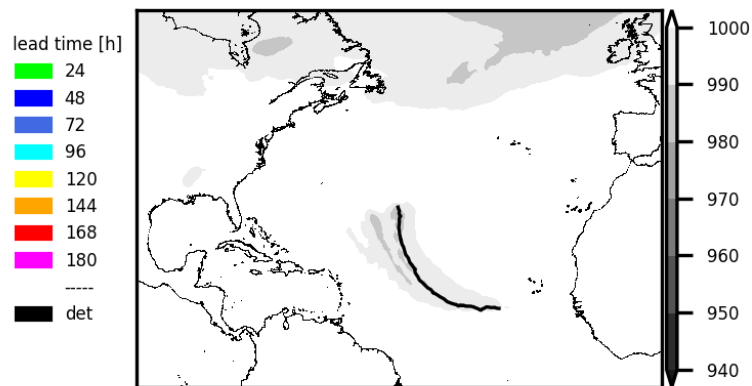
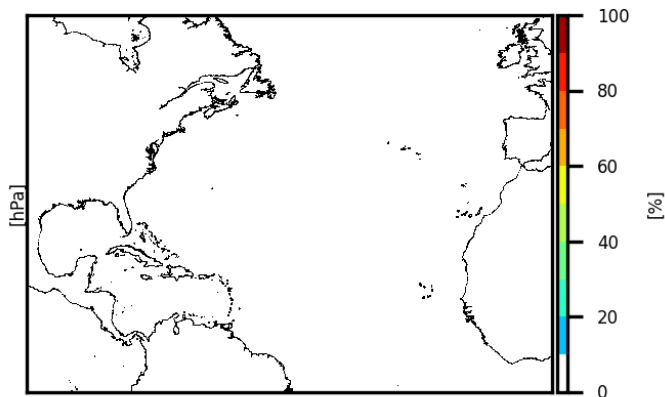


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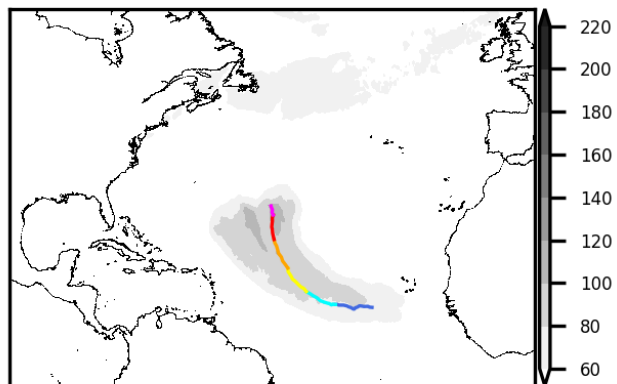


Larry

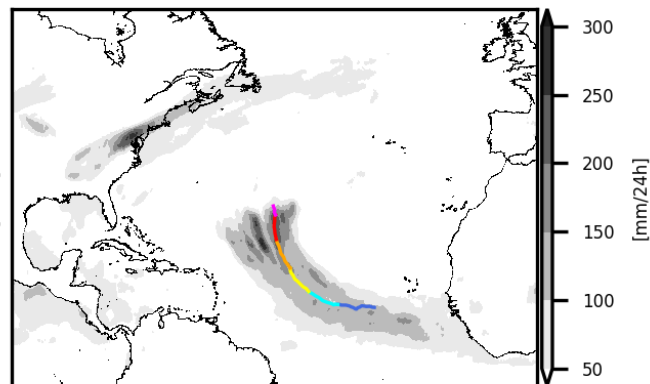
tracks & min of MSLP during forecast

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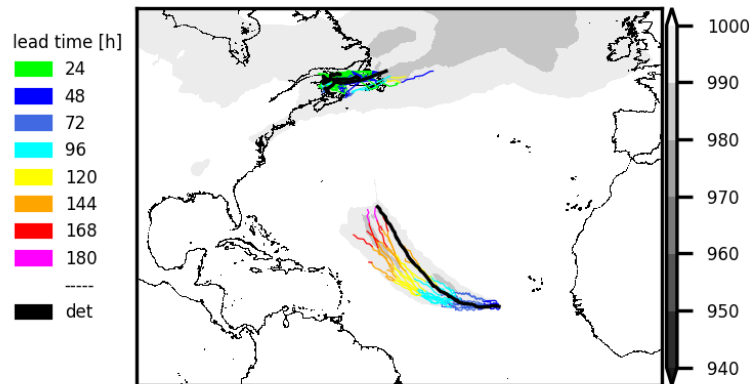
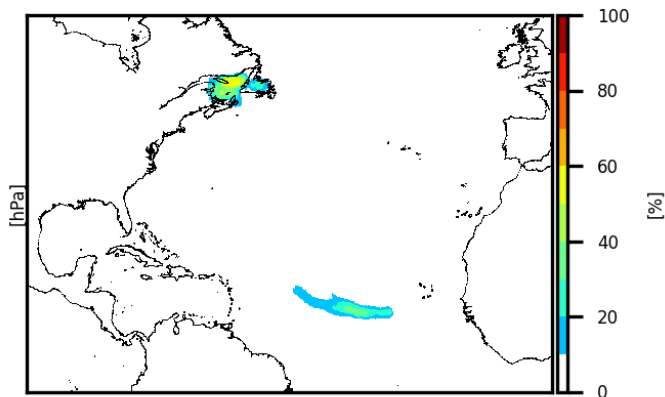


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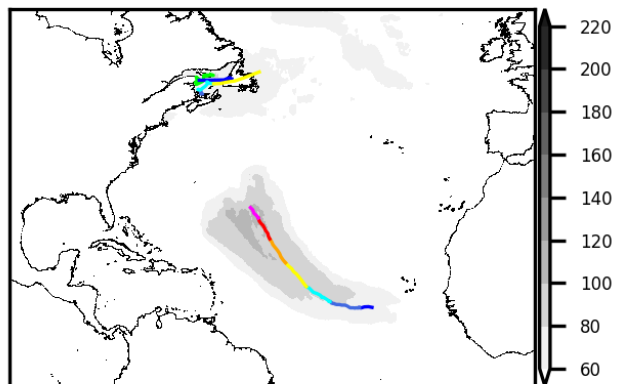


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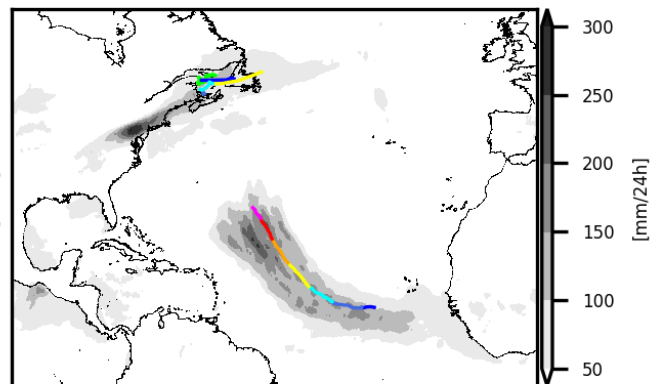
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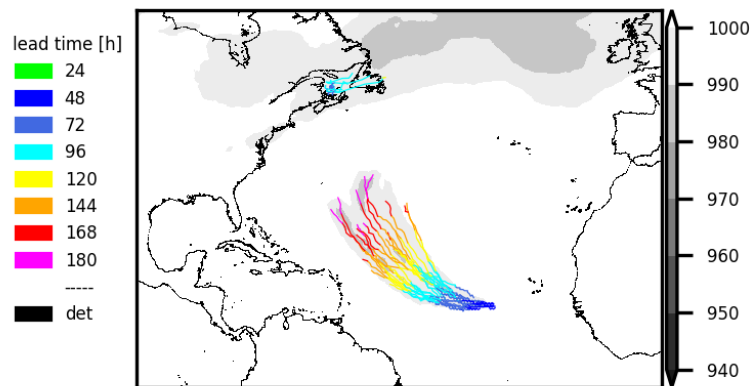
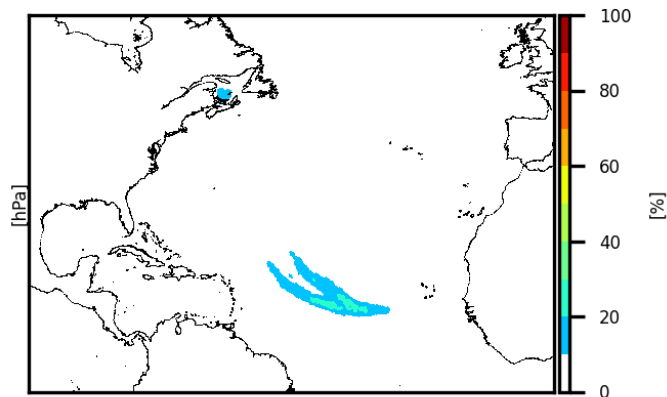


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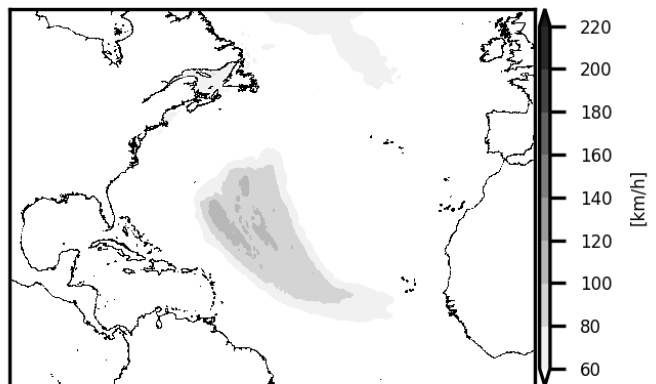


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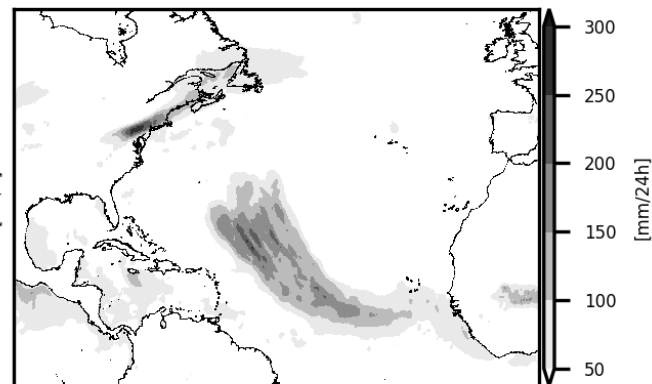
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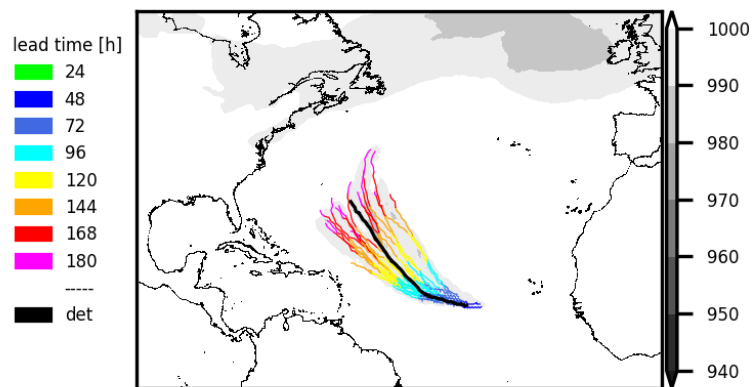
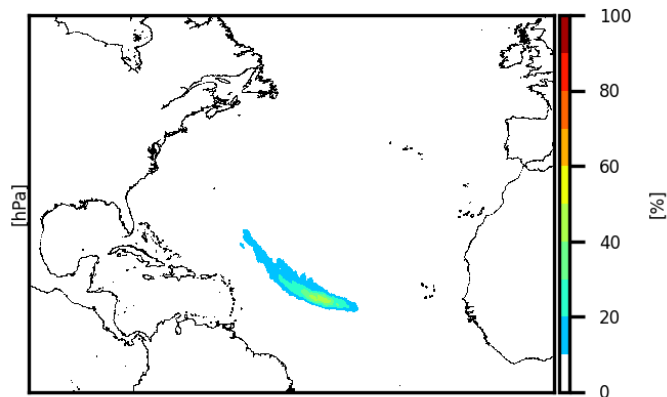


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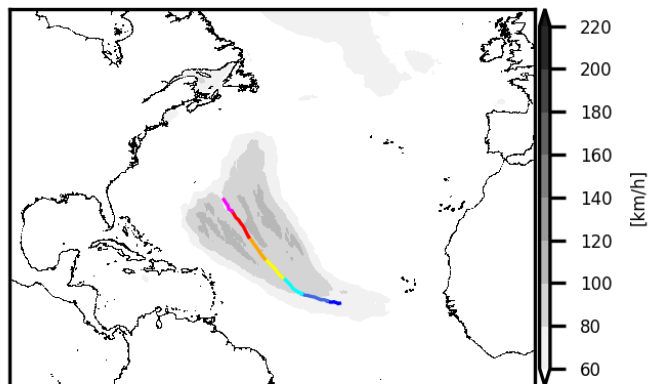


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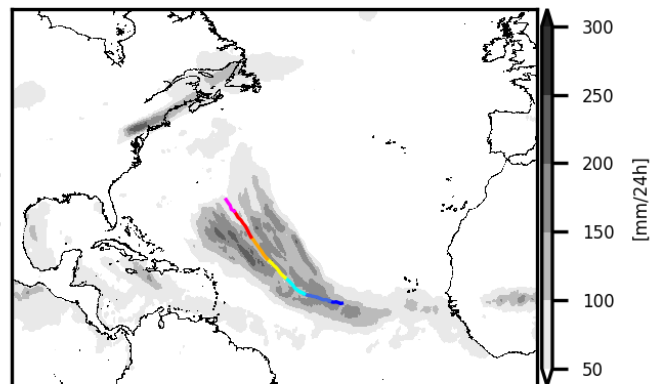
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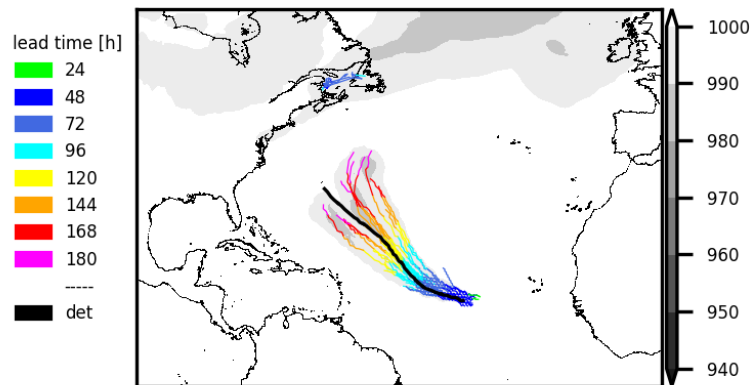
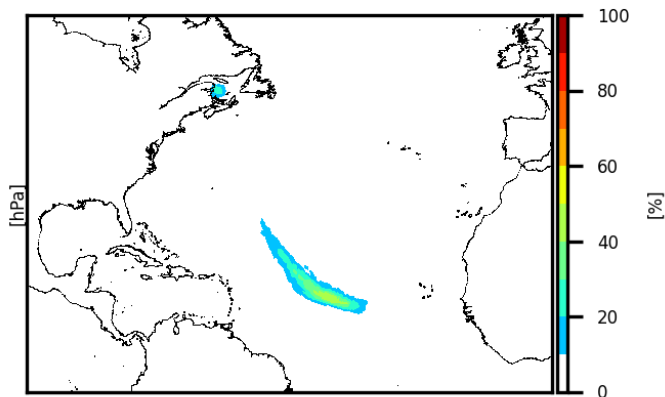


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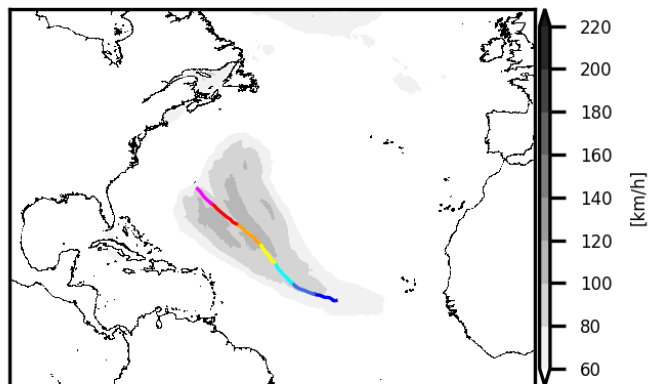


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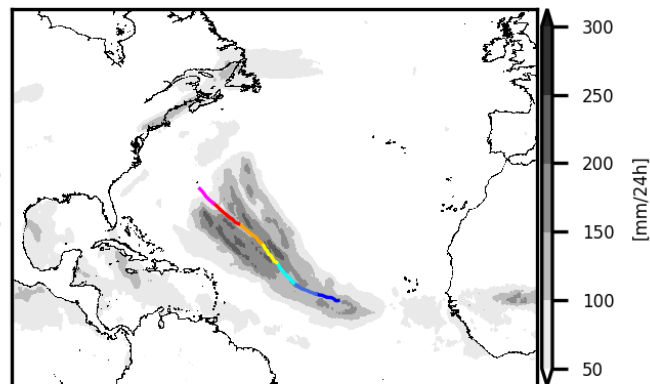
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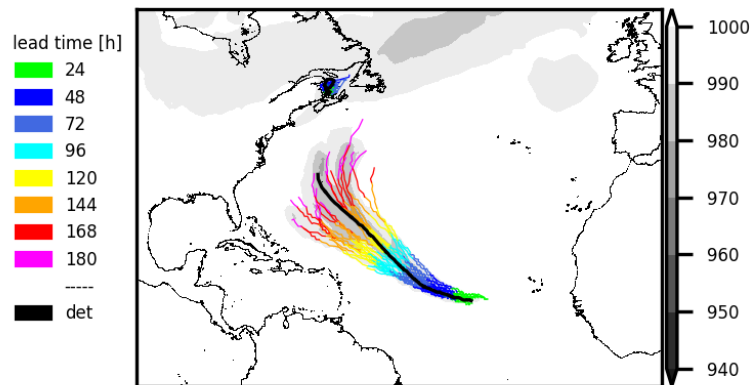
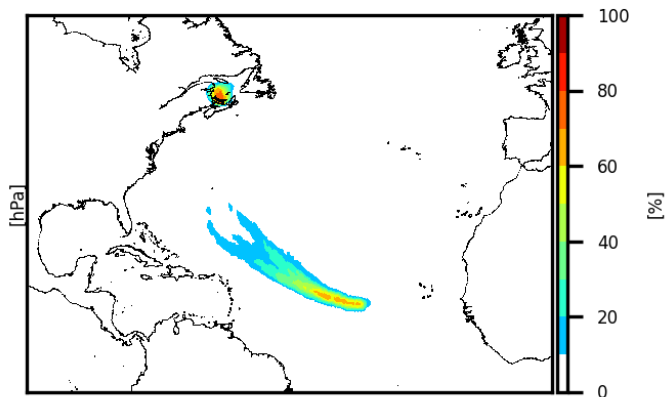


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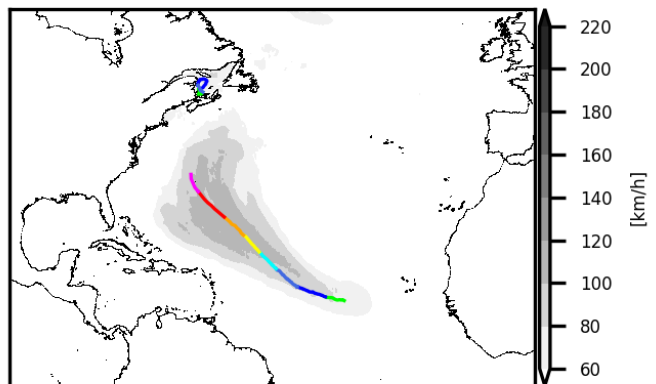


Larry

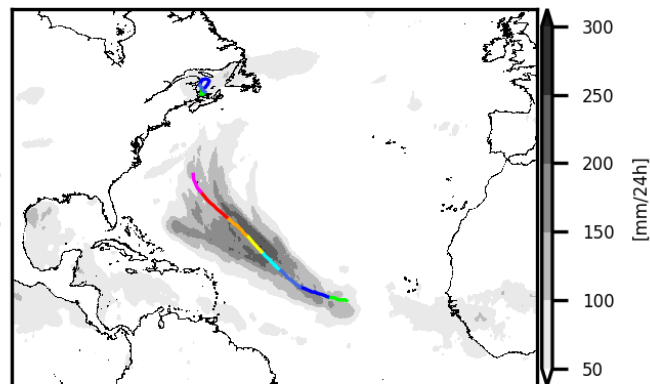
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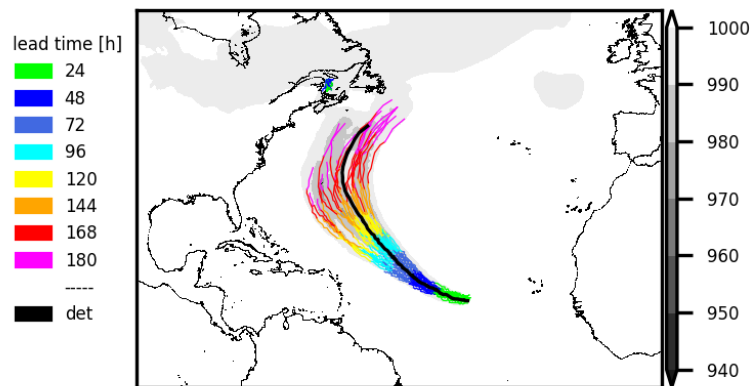
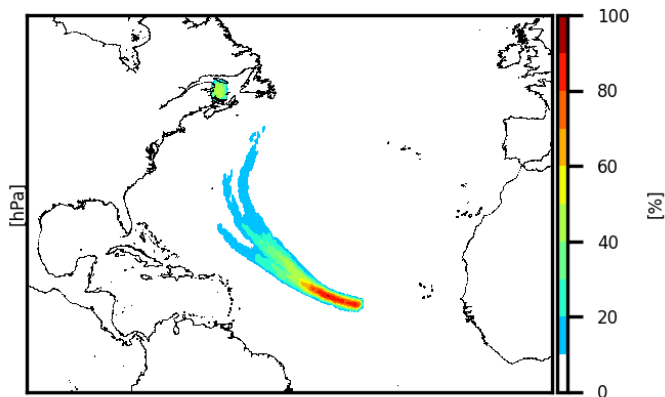


90% quantile of max rain/24h + det. Track

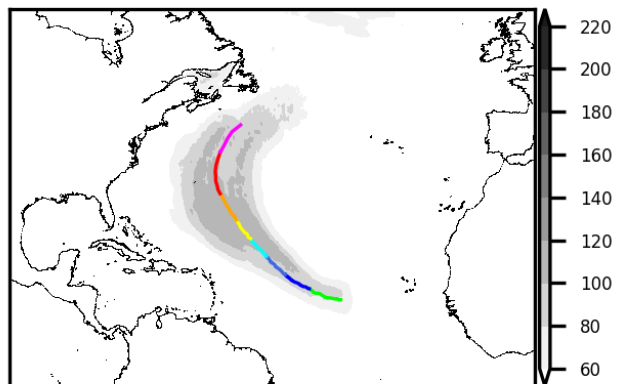


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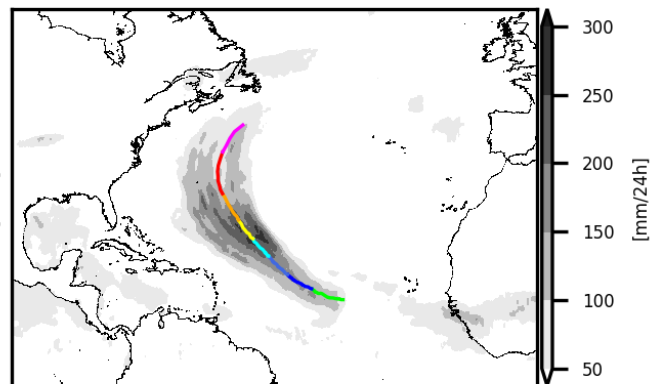
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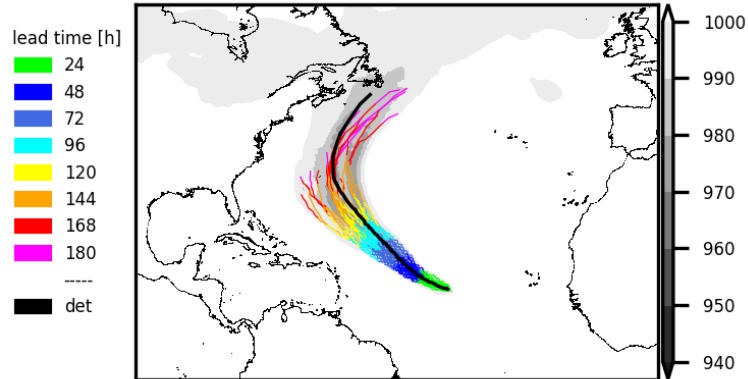


90% quantile of max rain/24h + det. Track

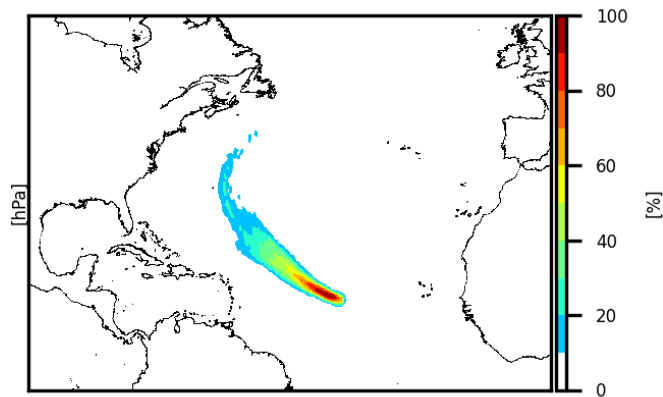


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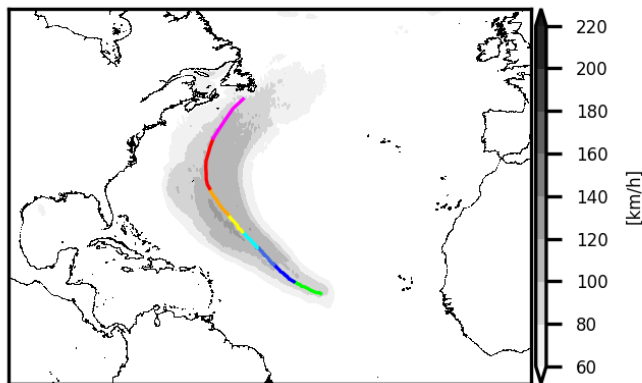
tracks & min of MSLP during forecast



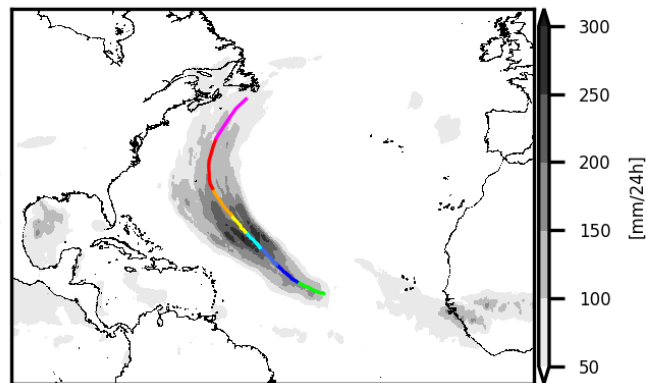
strike prob. (r~120km) / forecast range (0-180h)



90% quantile of max wind speed + det. Track



90% quantile of max rain/24h + det. Track



Larry

Thank you for listening!

ICON

